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SDAI: A key piece of software to manage the new wideband backend at Robledo

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abstract

A joint collaborative project was recently developed to provide the Madrid Deep Space Communications Complex with a state-of-the-art wideband backend.

The backend includes a new IF processor, as well as a FPGA-based FFT spectrometer, which manage thousands of spectroscopic channels in real time.

These equipment need to be controlled and operated by a common software, which has to synchronize activities among affected devices, and also with the observing program. The final output should be a calibrated spectrum, readable by standard radio astronomical tools for further processing.

The developed software at this end is named "Spectroscopic Data Acquisition Interface" (SDAI). SDAI is written in python 2.5, using PyQt4 for the User Interface.

This poster shows the modules built, a typical observing session, class structure, and some examples of header, logs, and astronomical results.

context

NASA Deep Space Network: a collection of international Complexes which support tracking and activities of space missions beyond the Earth orbits.

Located in Goldstone (USA), Canberra (Australia), and Madrid (Spain).

All DSN complexes host several high-sensitivity antennas, whose diameters range from 26 to 70 m.

These antennas are also used for radio astronomy observations, both in single-dish mode or as VLBI stations.

The Madrid Deep Space Communications Complex (MDSCC), has six antennas operating in several radio bands.

Two of them stand out: a K-band (18 - 26 GHz) receiver attached to the DSS-63 antenna (70 m in diameter), and a Q-band (38 - 50 GHz) receiver attached to the DSS-54 antenna (34 m in diameter).

A new complete, wideband backend for spectroscopic observations at MDSCC was recently built and put into operation. The new backend provides several GHz of instantaneous bandwidth, and resolutions from 7 to 200 kHz. Details in Rizzo et al. [1].

A new software was built to control and synchronize different parts of the backend, as well as to interact with the observing program and the antenna.

SDAI: Spectroscopic Data Acquisition Interface.

overview and operation

SDAI interacts with three kind of hardware:

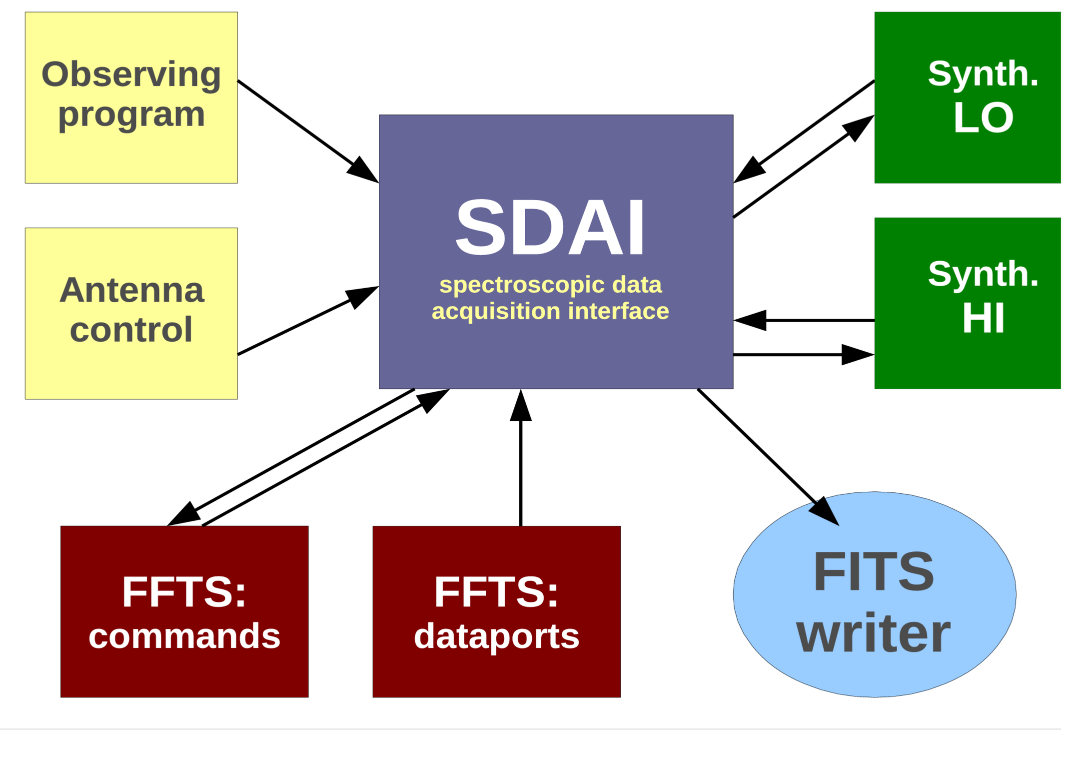
(1) Antenna. Communication is done through ethernet sockets.
- Observing program.
- Antenna control.

(2) IF processor. Communications done through serial ports.
- Synthesizer HI, from 18 to 26 GHz.
- Synthesizer LO, from 12 to 20 GHz.

(3) FFT spectrometer. Communication through ethernet sockets.
- FFTS commands, to configure and operate spectrometers.
- dataport, to retrieve and manage data.

SDAI synchronizes all items, and also writes a standard FITS file for each observation.

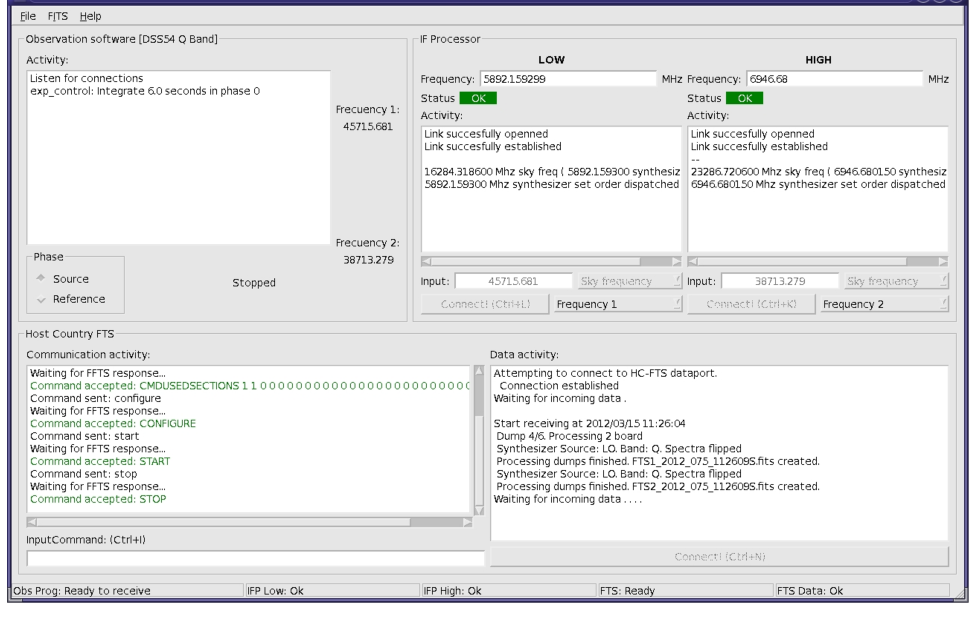
Minimum dump time: 1 milisec. Limited to 1sec by software.



SDAI has been written using the following:

- **Python 2.5** for code development.
- **PyQt4** for the GUI.
- **pyfits** for file management and writing.
- **numpy** for data processing.
- **struct** for unpacking binary data into python variables.
- **pyserial** for serial communication.
- **logging** for standard python log.
- **Tcl/Tk wrapper** to interact with the observing program.
- **C wrapper** to interact with the FFT spectrometer library.

a typical session



On the left, a snapshot of SDAI is shown.

SDAI integrates all its functionality in a single window. This helps remote operation by ssh tunnels, as described by Kuiper et al. [2]

Upper left frame. Interaction with observing program and antenna. The two tuned frequencies, integration status and activity are shown.

Upper right frame. Communication with the IF processor. This is done through the tuning of the synthesizers. Status and tuning are shown.

Lower left frame. FFT spectrometer operation, including a report of all introduced commands, and the possibility to do it by hand.

Lower right frame. Data port connection and activity. Information about integration progresses and FITS files.

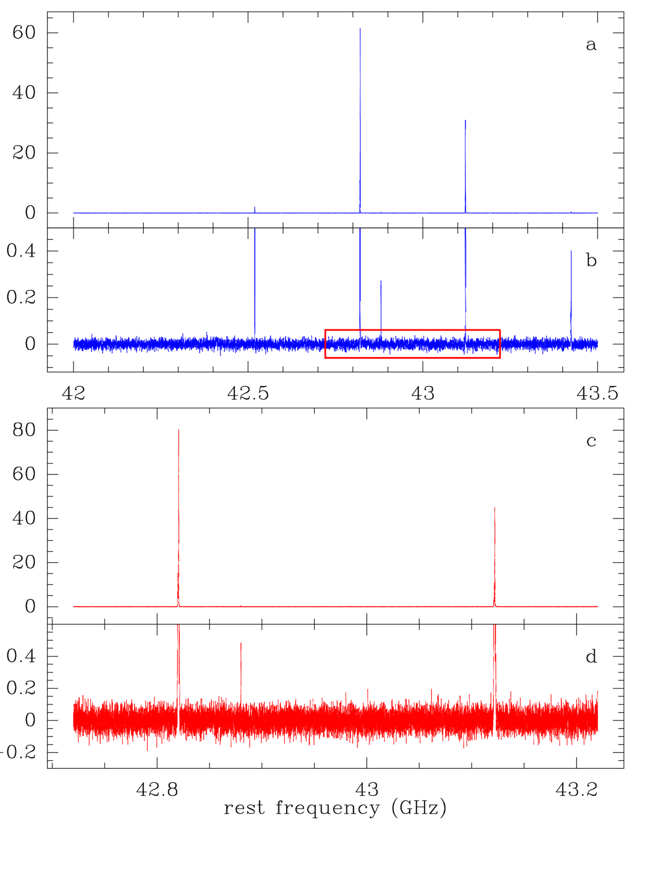
On the right, two 43-GHz spectra obtained using SDAI are depicted.

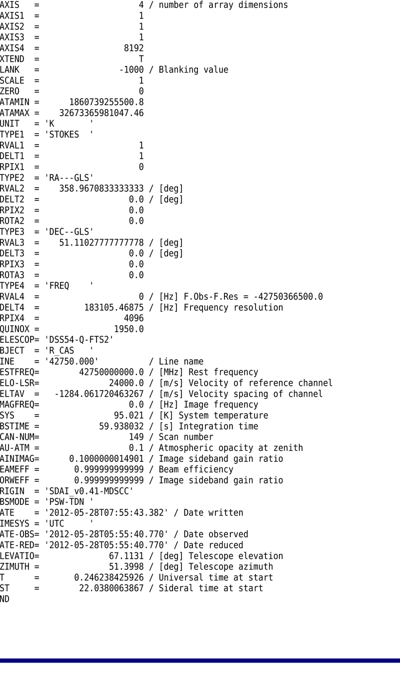
In figure **(a)** the spectrum has a total bandwidth of 1.5\,GHz. Ttwo intense lines are noted.

Figure **(b)** shows the same, but zoomed in intensity to emphasize three other lines also detected.

The gray rectangle correspond to the 500-MHz band depicted in Figure **(c)**, which correspond to the other polarization and has been gathered simultaneously.

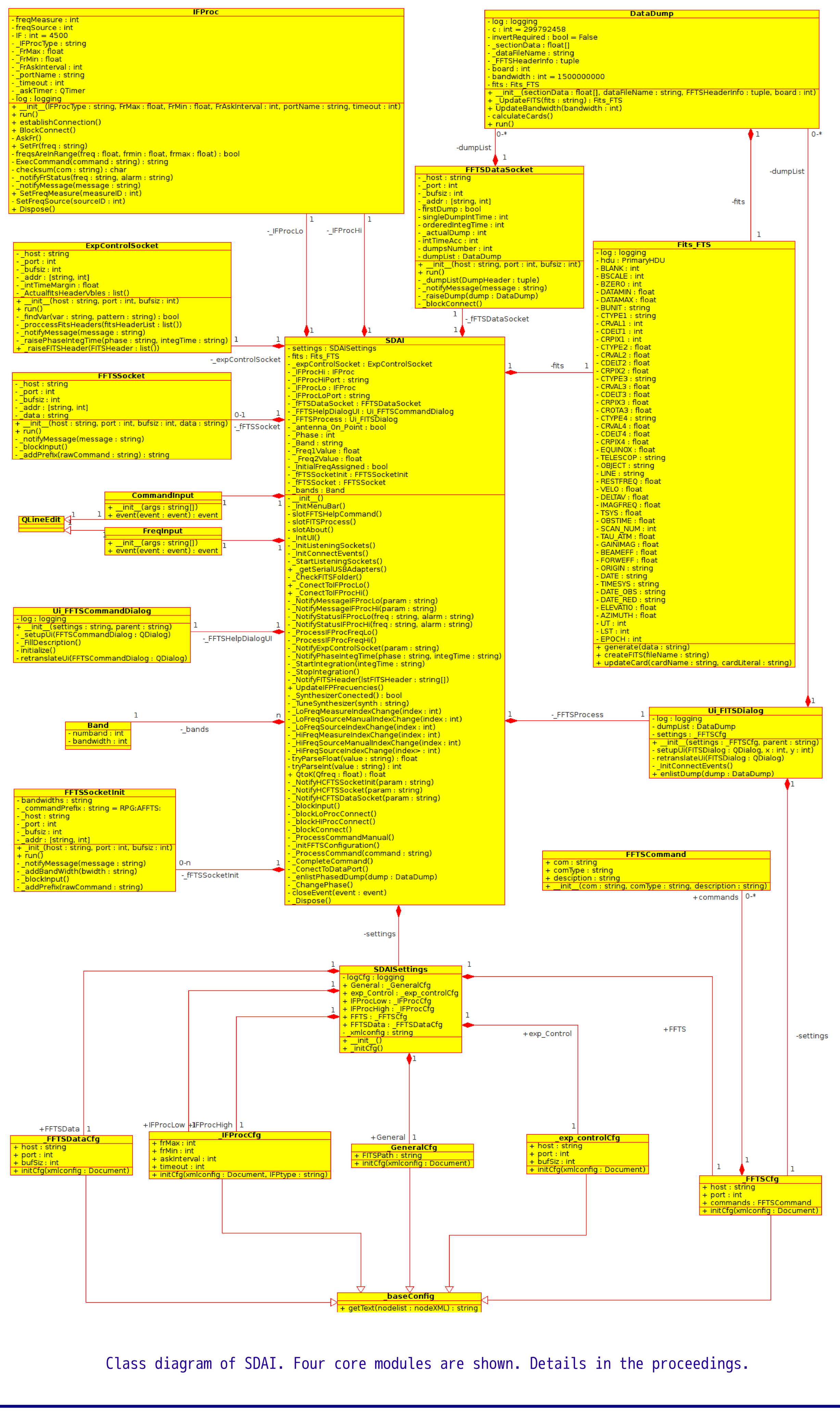
Figure **(d)** is the same as (c), but zoomed in intensity to remark the low-level lines.





A FITS header example, as written by SDAI in the 0.41 version.

class diagram



Class diagram of SDAI. Four core modules are shown. Details in the proceedings.

references

[1] Rizzo, J. R., Pedreira, A., Gutierrez M., Sotuela, I., Larrañaga, J. R., Ojalvo, L., Franco, M., Cernicharo, J., Garcia Miro, C., Castro Ceron, J. M., Kuiper, T. B. H., Vazquez, M., Calvo, J., and Baquero, A., "The wideband backend at the MDSCC in Robledo. A new facility for radio astronomy at Q- and K- bands", A&A, 542, A36, http://dx.doi.org/10.1051/0004-6361/201118347 (2012).

[2] Kuiper, T. B. H., Majid, W., Martinez, S., Garcia Miro, C., and Rizzo, J. R., "Remote Observing with NASA's Deep Space Network", in Observatory Operations: Strategies, Processes, and Systems IV, Peck, A. B., Seaman, R. L., and Comeron, F., eds., Proc. SPIE 8448, in press (2012).